

National Aeronautics and Space Administration



A LUNAR GALLERY

AN ARTISTIC LOOK AT EARTH'S MOON

NASA
LUNAR SCIENCE
INSTITUTE

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Welcome to our LUNAR GALLERY

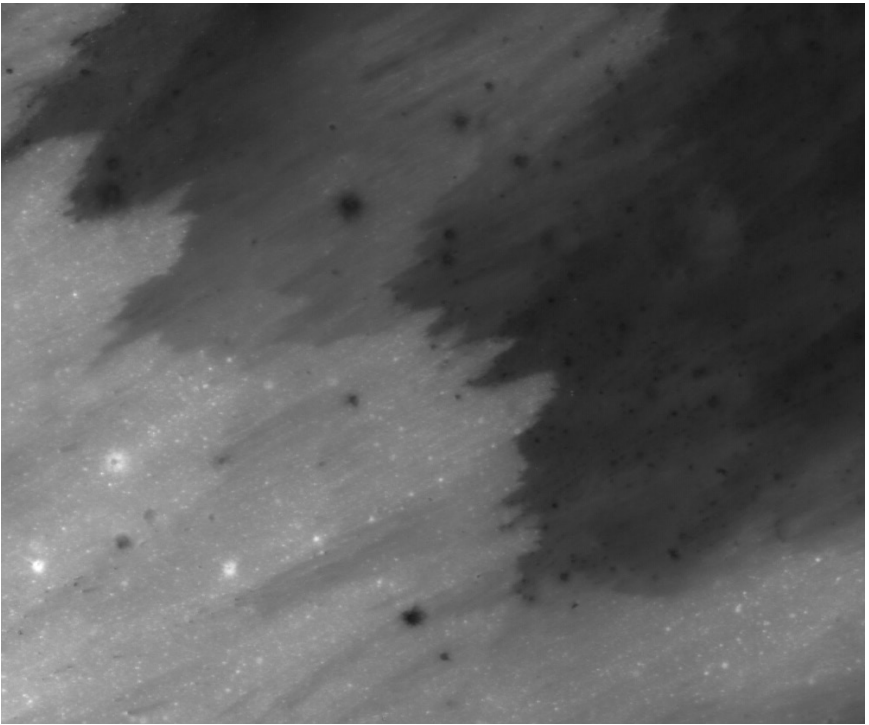
Spacecraft have imaged the surface of the Moon now for over four decades, providing insights into the history, atmosphere, and geology of our nearest neighbor in space. Recent scientific discovery has resulted in a resurgence of lunar science. The Apollo missions were only the beginning. More and more we are realizing that there is a whole new unexplored world right in Earth's backyard. Where lunar exploration is concerned, we have literally only begun to scratch the surface.

The Lunar Gallery showcases selected lunar images and data taken from orbit by visiting spacecraft. These images were chosen for their aesthetic rather than scientific value. Moments of awe can change perceptions. When art works as a tool for lunar science, it can inspire curiosity and understanding such that the Moon becomes just as new as once it was.

By sharing the excitement of lunar science and exploration, the NASA Lunar Science Institute, headquartered at NASA Ames Research Center, Moffett Field, California, is helping people gain a better understanding of the Moon and maintain curiosity about the latest discoveries in lunar science.

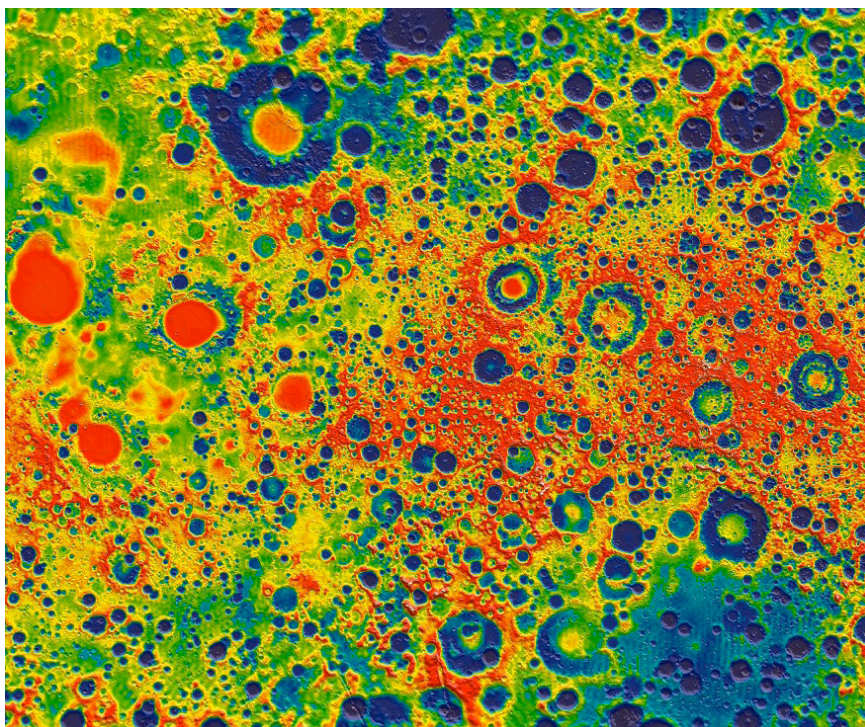
After all, it's not just any moon, it's our Moon.

*For more information about NASA's Lunar
Exploration, visit lunarscience.nasa.gov*



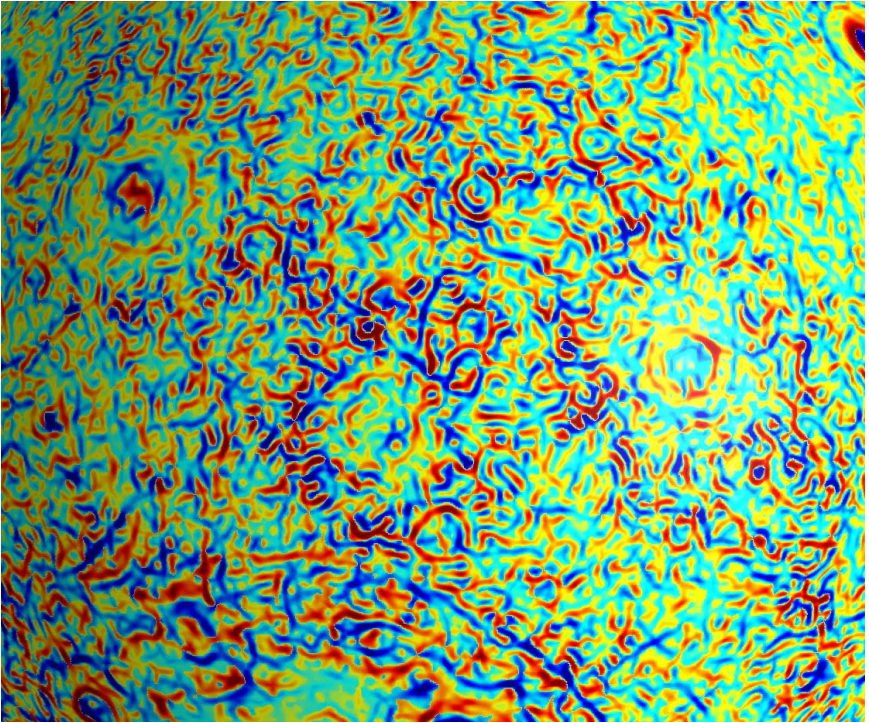
Ejecta Blanket Across the Lunar Surface

The crater above looks like any ordinary bright spot in lower resolution images (100 m/pixel). However, the Lunar Reconnaissance Orbiter's (LRO) high resolution (52 cm/pixel) images reveal extraordinary detail. Here layers of ejecta stream out across the surface. Small craters churn up and expose both the fresh material within the ejecta blanket (those that appear bright) and reveal mature material from beneath it (those that appear dark).



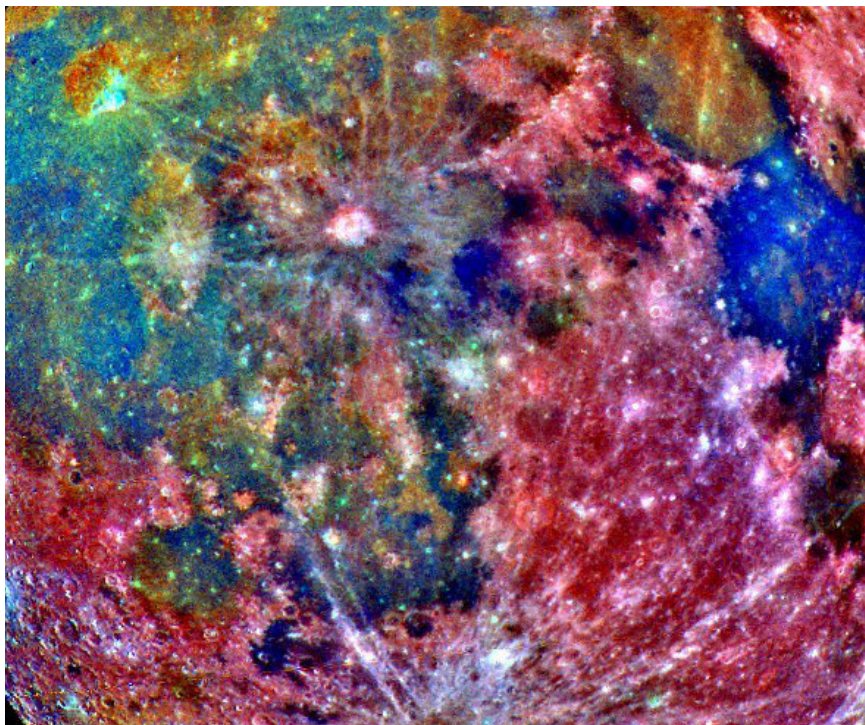
Gravity Field of the Moon

This map shows the gravity field of the Moon as measured by NASA's Gravity Recovery and Interior Laboratory (GRAIL) mission. The viewing perspective, known as a Mercator projection, shows the far side of the Moon in the center and the nearside (as viewed from Earth) at either side. Reds correspond to mass excesses which create areas of higher local gravity, and blues correspond to mass deficits which create areas of lower local gravity.



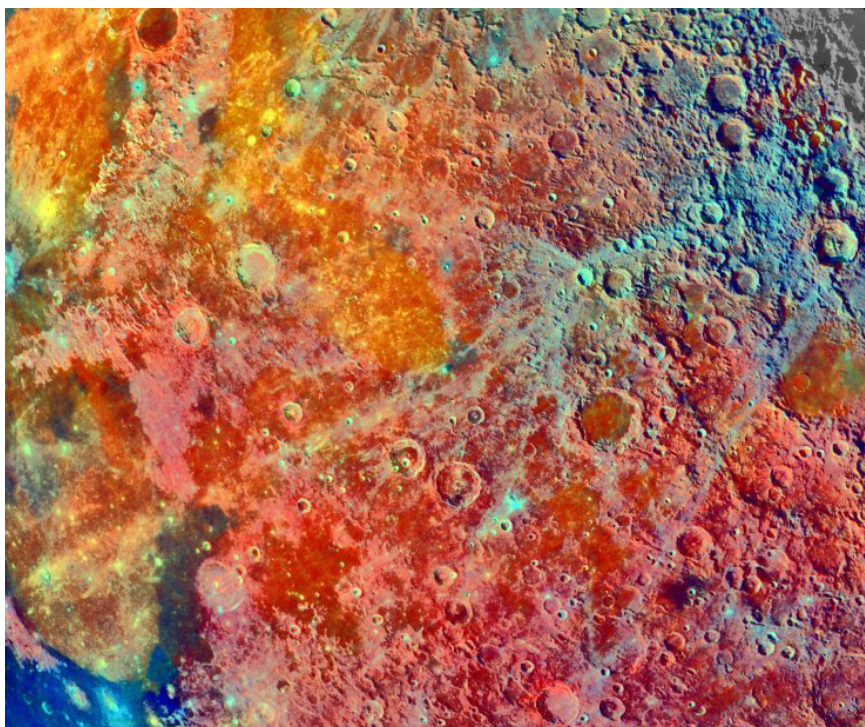
Lunar Gravity Gradients

This Moon map shows the gravity gradients calculated by NASA's Gravity Recovery and Interior Laboratory (GRAIL) mission. Red and blue correspond to stronger gravity gradients. The GRAIL mission launched in 2011 on a Delta II launch vehicle and used high-quality gravity field mapping of the Moon to determine the Moon's interior structure.



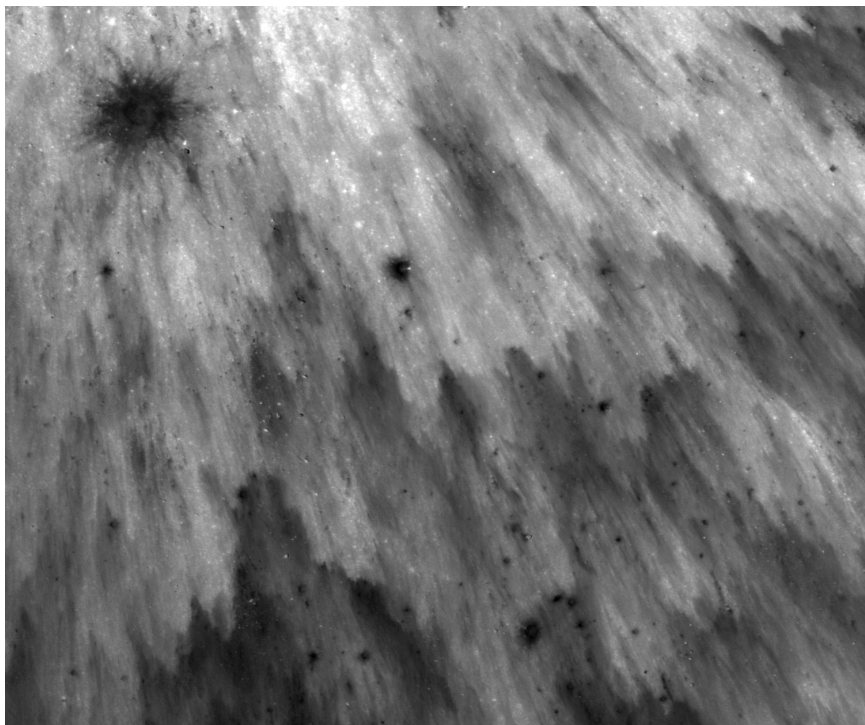
False Color Mosaic

The false-color processing used to create this lunar image is helpful for interpreting the surface soil composition. Areas appearing red generally correspond to the lunar highlands, while blue to orange shades indicate the ancient volcanic lava flow of a mare, or lunar sea. Bluer mare areas contain more titanium than do the orange regions. Mare Tranquillitatis, seen as a deep blue patch on the right, is richer in titanium than Mare Serenitatis, a slightly smaller circular area immediately adjacent to the upper left of Mare Tranquillitatis. The small purple areas found near the center are pyroclastic deposits formed by explosive volcanic eruptions.



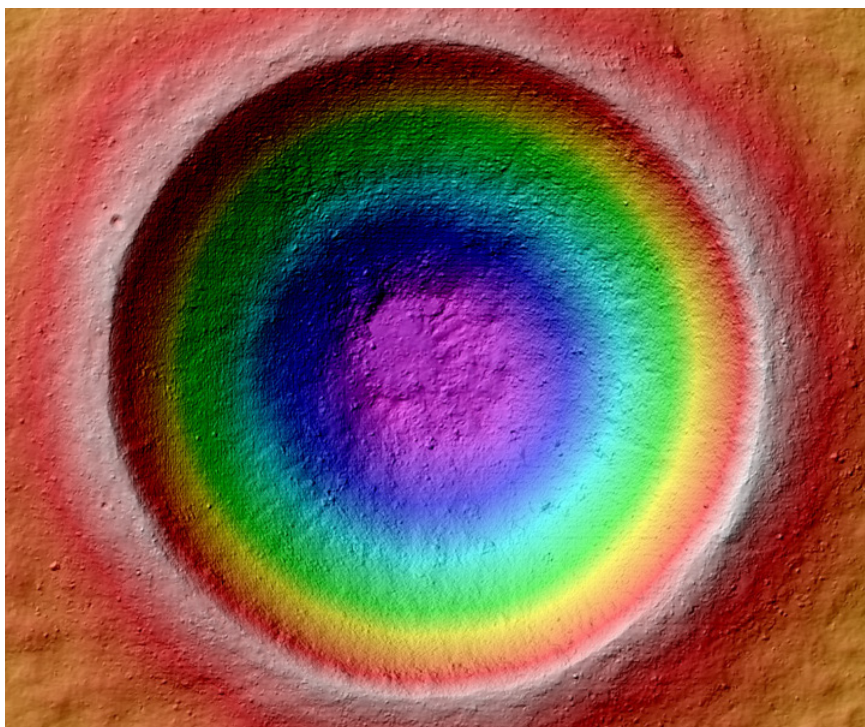
False Color Mosaic 2

This false-color mosaic was constructed from a series of 53 images taken through three spectral filters by Galileo's imaging system as the spacecraft flew over the northern regions of the Moon on December 7, 1992. The color mosaic shows compositional variations in parts of the Moon's northern hemisphere. Bright pinkish areas are highlands materials. Blue to orange shades indicate volcanic lava flows. Thin mineral-rich soils associated with relatively recent impacts are represented by light blue colors; the youngest craters have prominent blue rays extending from them.



Action Shot

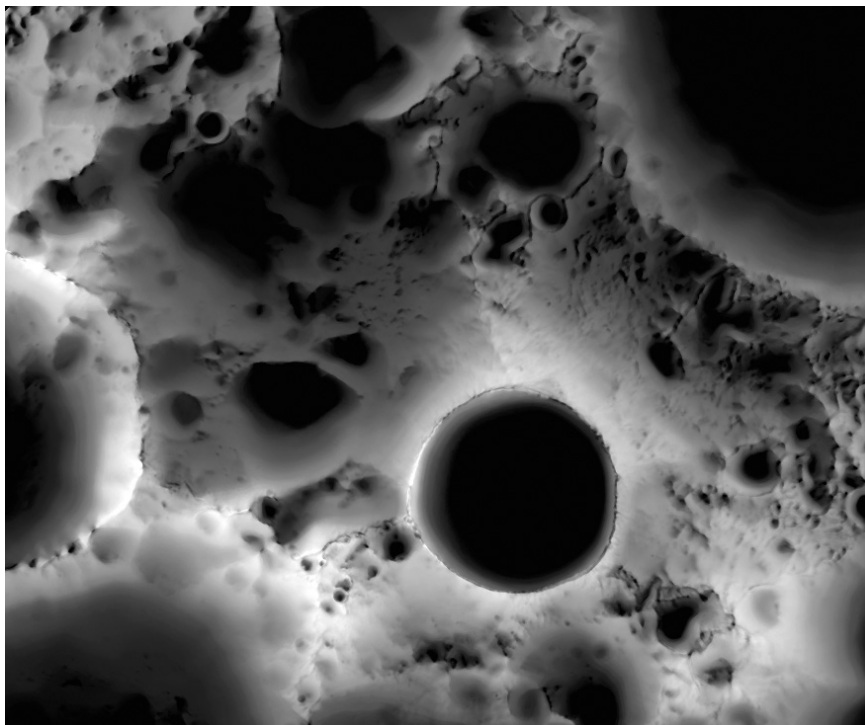
This small, unnamed crater displays a beautiful ejecta pattern resembling a starburst. Looking at this image you can almost imagine the shower of ejecta falling to the ground. The pattern formed out of high and low reflectance areas is due to the freshness of the ejecta. The LRO mission is expected to return over 70 terabytes of image data.



Barnstorming Linné Crater

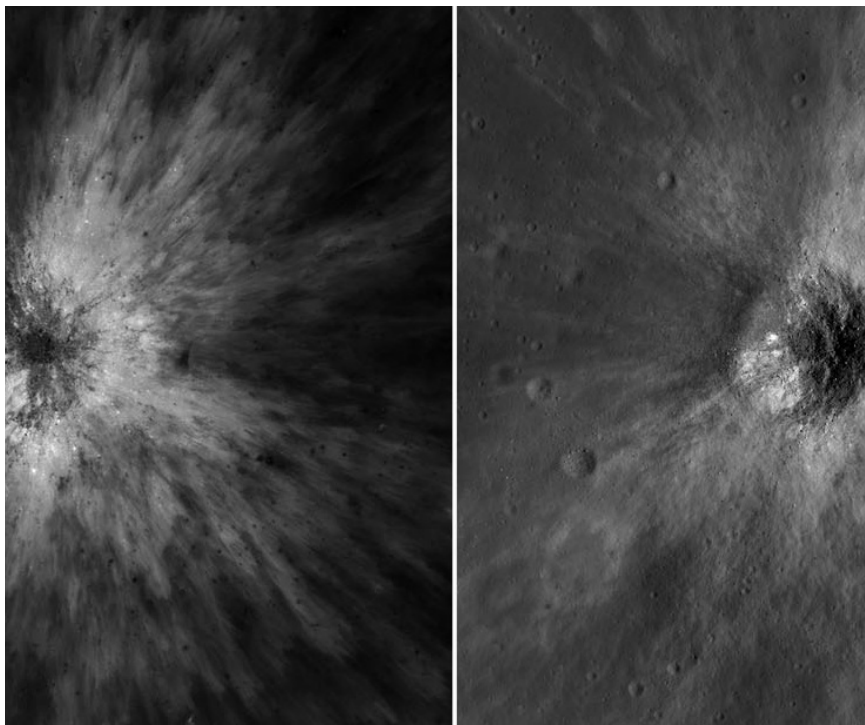
Color coded shaded relief map of Linné crater (2.2 km diameter) created from a stereo topographic model. The colors represent elevations; cool colors are lowest and hot colors are highest.

The Lunar Reconnaissance Orbiter Camera (LROC) was designed to acquire data for landing site certification and to conduct polar illumination studies and global mapping. LROC consists of a pair of narrow-angle cameras (NAC) and a single wide-angle camera (WAC).



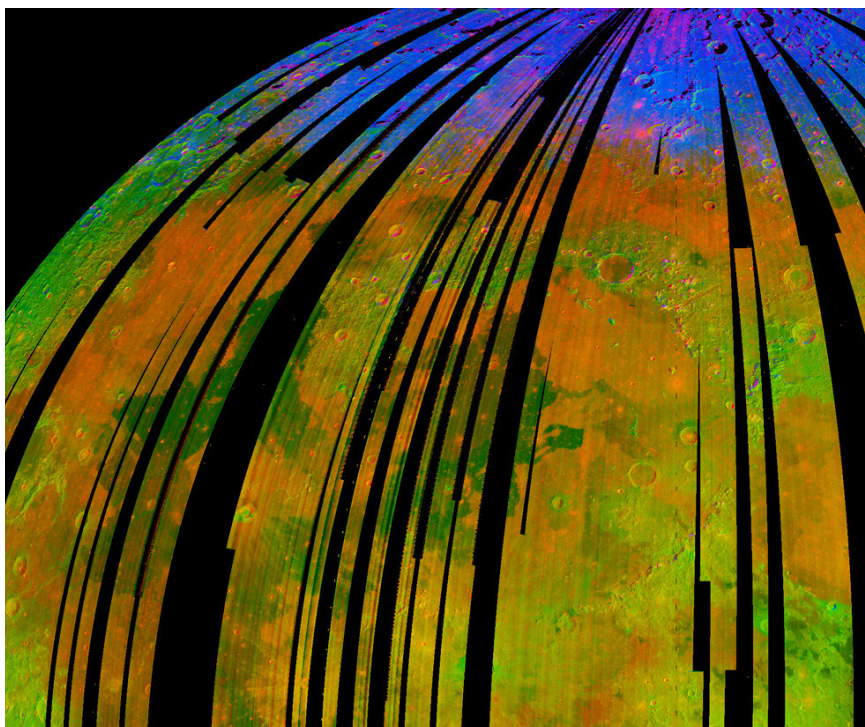
South Pole Illumination Map

Multi-temporal illumination map of the lunar south pole, with Shackleton crater (19 kilometers diameter, or 12 miles) in the center. The spin axis of the Moon is tilted by only 1.54° (compared to Earth's 23.5°), leaving some areas near the poles in permanent shadow while other nearby regions remain sunlit for the majority of the year. These maps will provide the foundation for planning future robotic and human missions to the poles.



Splendors of Mare Smythii

This image shows the interior of a fresh impact crater (approximately 300 meters (328 yards) in diameter) in the Mare Smythii Constellation Region of Interest. In the high-sun image above, it is hard to recognise topographic features because there are no shadows. The view at left, paired with a lower-sun image of the same crater on the right, gives a sharper view of small scale features such as boulders.

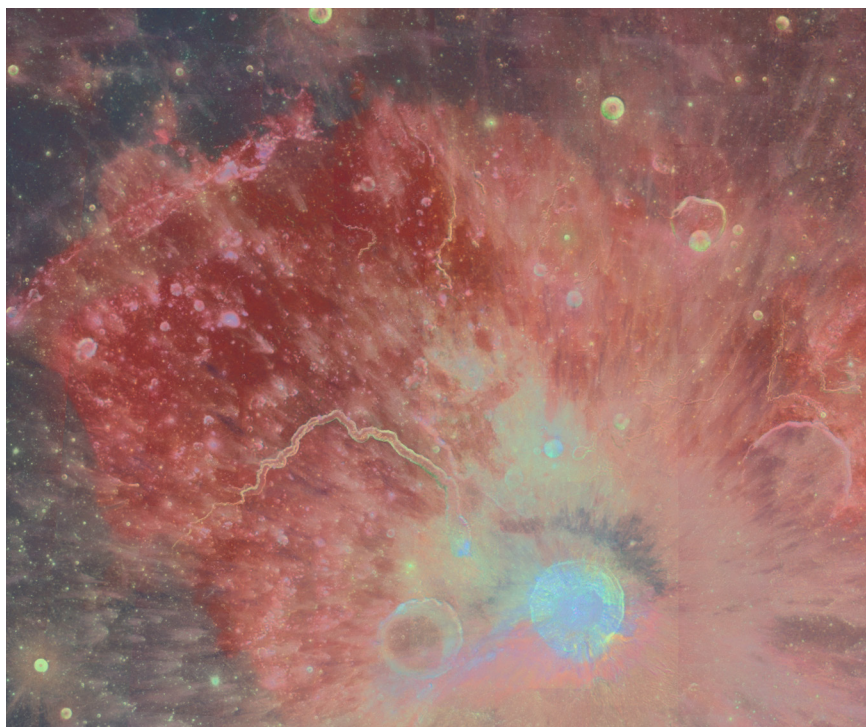


Water Detected at High Latitudes

This image of the Moon is from NASA's Moon Mineralogy Mapper on the Indian Space Research Organization's Chandrayaan-1 mission. It is a three-color composite of reflected near-infrared radiation from the sun, and illustrates the extent to which different materials are mapped across the surface of the Moon.

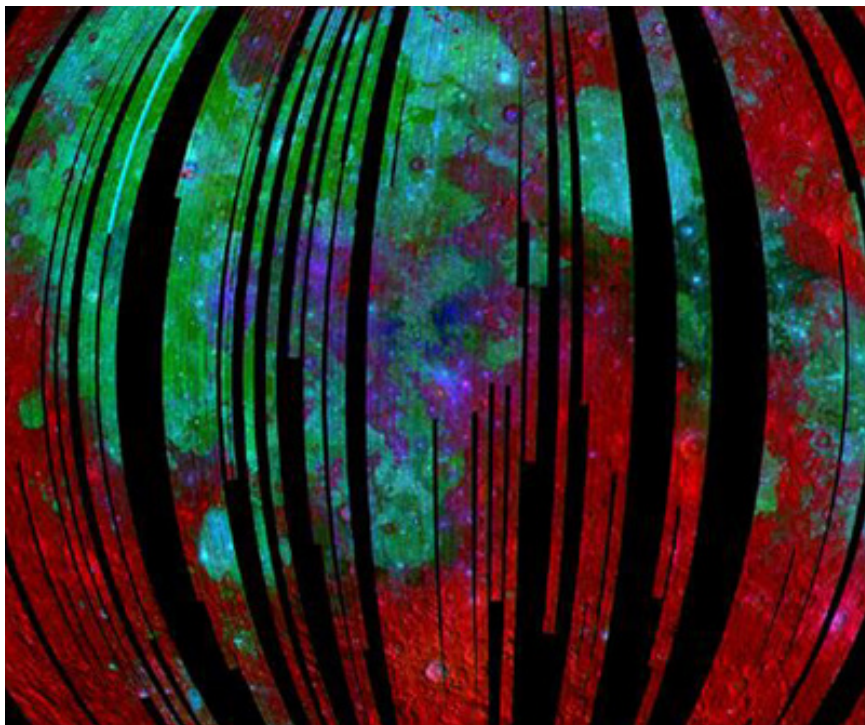
Small amounts of water and hydroxyl (blue) were detected on the surface of the Moon at various locations. This image illustrates their distribution at high latitudes toward the poles.

Blue shows the signature of water and hydroxyl molecules as seen by a highly diagnostic absorption of infrared light with a wavelength of three micrometers. Green shows the brightness of the surface as measured by reflected infrared radiation from the sun with a wavelength of 2.4 micrometers, and red shows an iron-bearing mineral called pyroxene, detected by absorption of 2.0-micrometer infrared light.



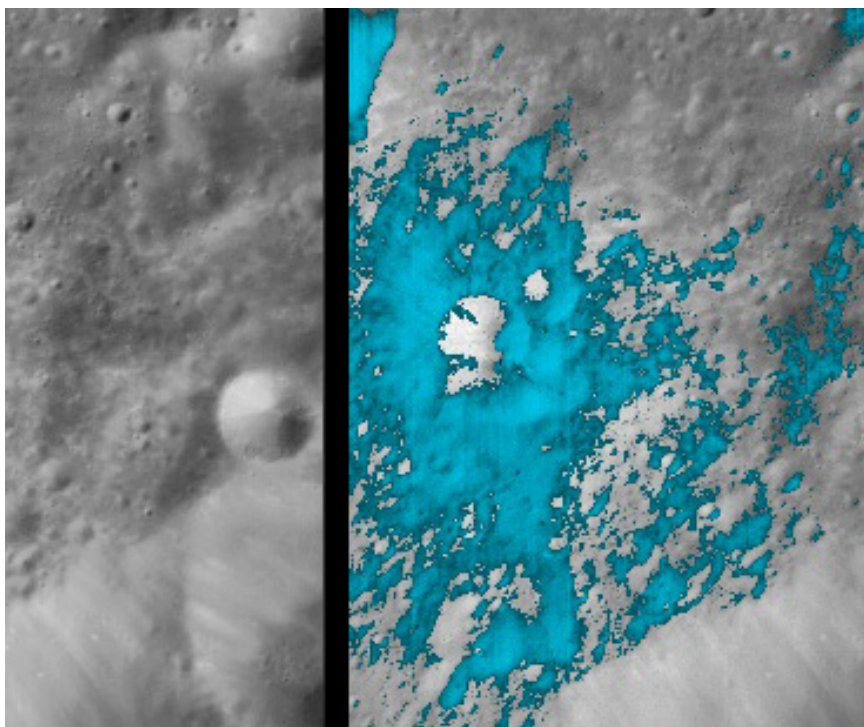
Multispectral Mosaic of the Aristarchus Crater and Plateau

A multispectral mosaic of the Aristarchus region taken by the Clementine spacecraft shows one of the most diverse and interesting areas on the Moon, including the 42-km-diameter crater itself (blue) and its ejected dust and rubble. About 500 Clementine images acquired through three spectral filters (415, 750, and 1000 nm) were processed and combined into this multispectral mosaic.



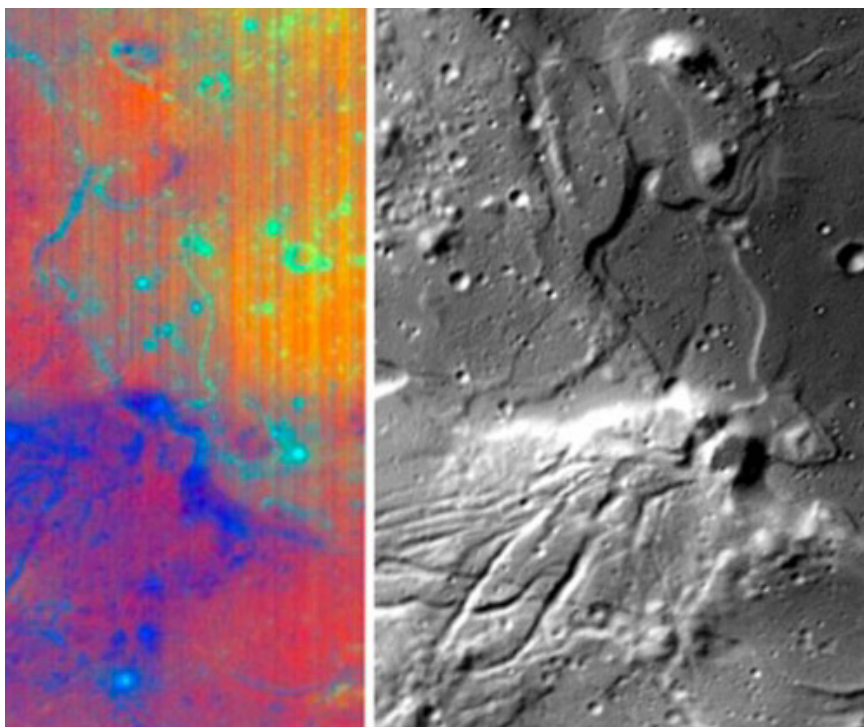
Mineral Mapping the Moon

This is an early mineral map derived from the different reflected light, or spectral, signatures, measured by NASA's Moon Mineralogy Mapper on board the Indian Space Research Organization's Chandrayaan-1 spacecraft. The green, purple and blue areas are covered with iron-rich lava flows. These are similar to the lava flows of Hawaii. The red and pink regions contain the mineral plagioclase. Plagioclase is one of the minerals found in granite rocks on Earth, such as the granite of Yosemite National Park.



Water Around a Fresh Crater

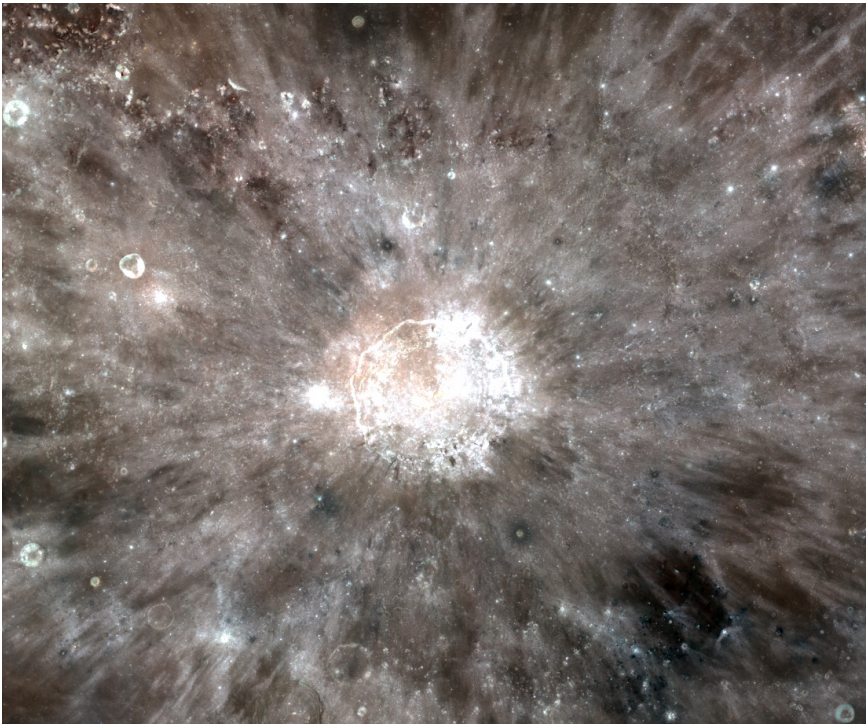
These images show a very young lunar crater on the side of the Moon that faces away from Earth, as viewed by NASA's Moon Mineralogy Mapper on the Indian Space Research Organization's Chandrayaan-1 spacecraft. On the left is an image showing brightness at shorter infrared wavelengths. On the right, the distribution of water-rich minerals (light blue) is shown around a small crater. Both water- and hydroxyl-rich materials were found to be associated with material ejected from the crater.



NASA's Moon Mineralogy Mapper

Different wavelengths of light provide new information about the Orientale Basin region of the Moon in a composite image taken from an altitude of 100 kilometers (62 miles) by NASA's Moon Mineralogy Mapper, a guest instrument aboard the Indian Space Research Organization's Chandrayaan-1 spacecraft.

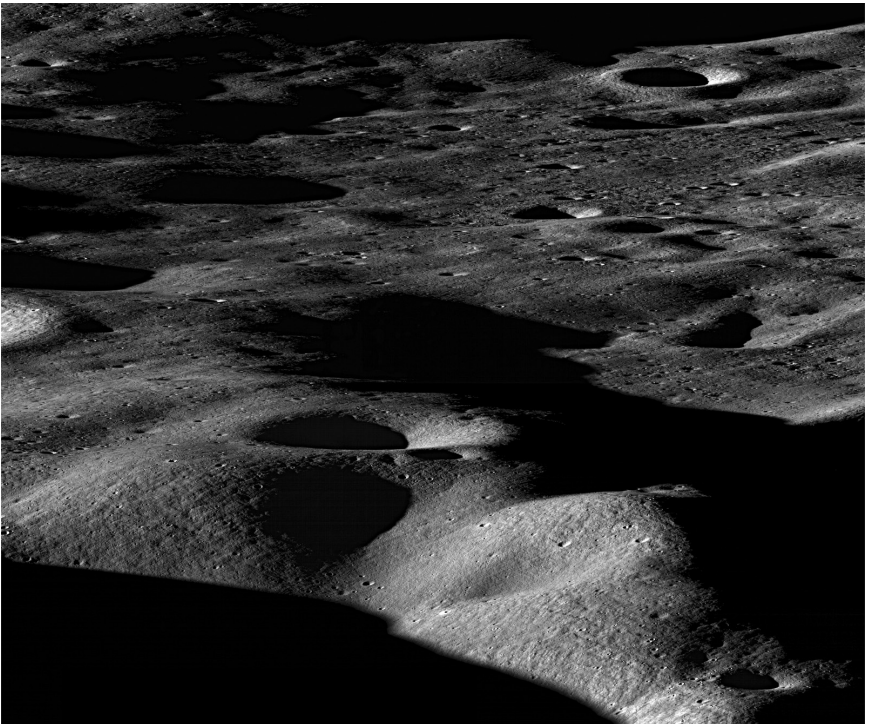
The image strip on the left is a color composite of data from 28 separate wavelengths of light reflected from the Moon. The blue to red tones reveal changes in rock and mineral composition, and the green color is an indication of the abundance of iron-bearing minerals such as pyroxene. The image strip on the right is from a single wavelength of light that contains thermal emission, providing a new level of detail on the form and structure of the region's surface. The Moon Mineralogy Mapper provides scientists their first opportunity to examine lunar mineralogy at high spatial and spectral resolution.



Absolute Time

This visible to ultraviolet portrait of Copernicus crater is 458 km wide.

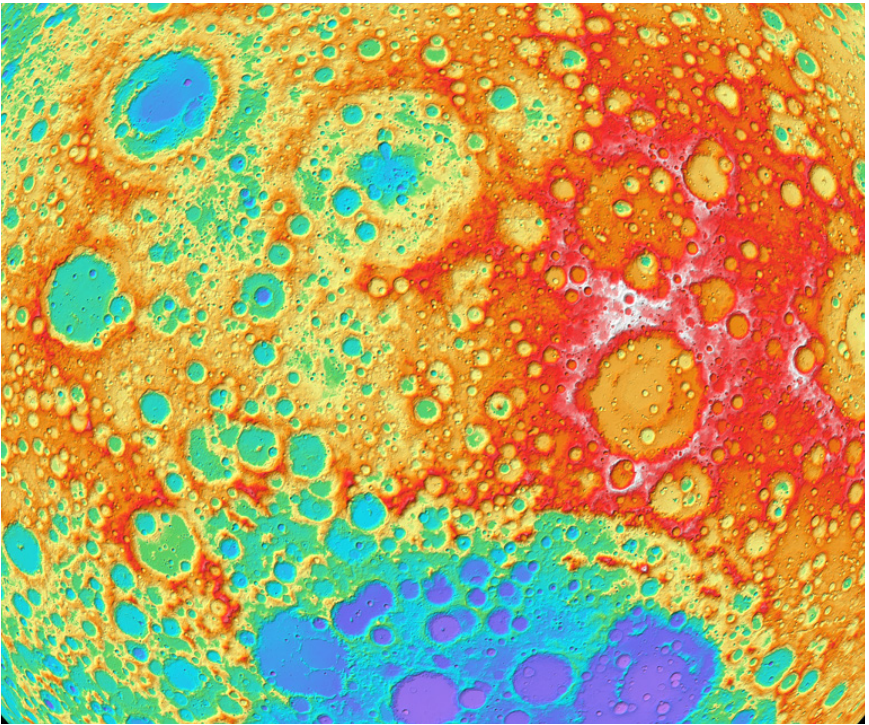
Understanding how scientists determine the relative age of geologic units on the Moon is straightforward, most of the time. One simply follows the law of superposition; what is on top is younger, what is below is older. In some cases superposition relations are not clear, so scientists then compare crater densities. That is the number of impact craters on a common size of ground. Since impacts occur randomly both in time and on the Moon's surface, any piece of ground has an equal chance of being hit. Over time the number craters in a given area increases. Simply stated, the older an area the more craters you will find.



Mountains of the Moon

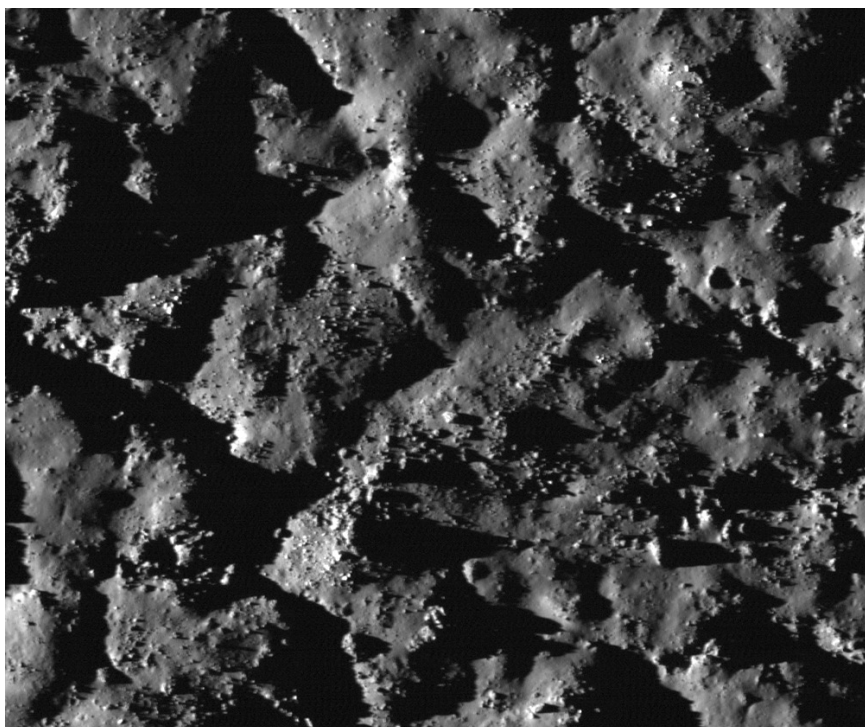
Most mountains on the Earth are formed as plates collide and the crust buckles. Not so for the Moon, where mountains are formed as a result of impacts. Images taken looking across the landscape rather than straight down really bring out topography and help us visualize the lunar landscape. Foreground is about 15 km wide, view is northeast across the north rim of Cabeus crater.

Cabeus crater is relatively old, 100 km in diameter, and contains significant areas of permanent shadow. Such regions are of great interest because they may harbor significant deposits of ices (water, methane, etc).



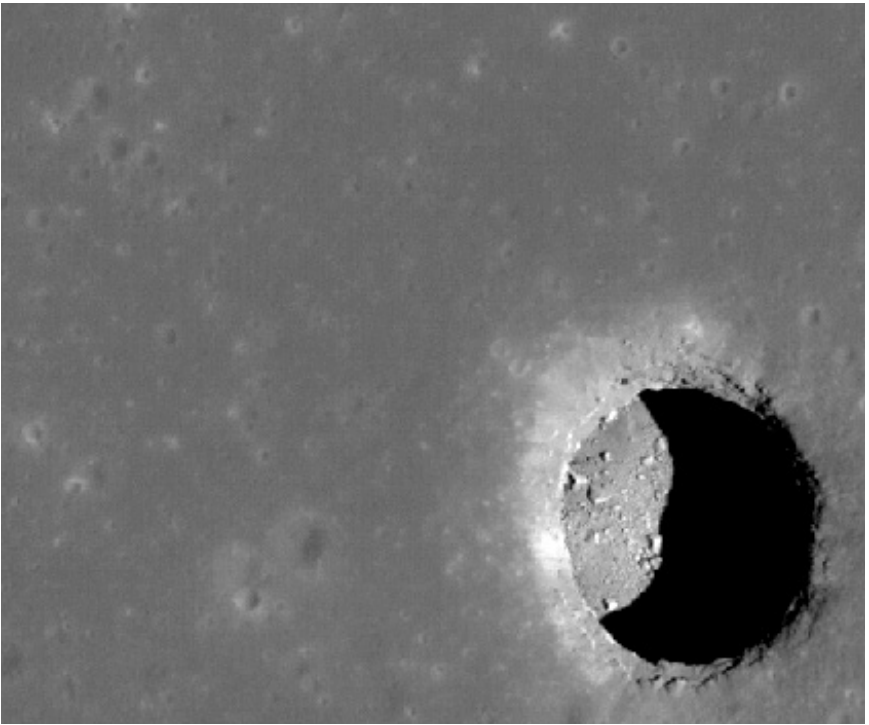
Lunar Topography as Never Seen Before

This amazing global topographic map of the Moon shows the ups and downs over nearly the entire Moon, at a scale of 100 meters across the surface, and 20 meters or better vertically. Shaded relief images can be created by illuminating the surface from a given Sun direction and elevation above the horizon, and the resulting grayscale pixels are painted with colors that represent the altitude. Visualizations like these allow scientists to view the surface from very different perspectives, providing a powerful tool for interpreting the geologic processes that have shaped the Moon.



Chaotic Crater Floor in Tycho

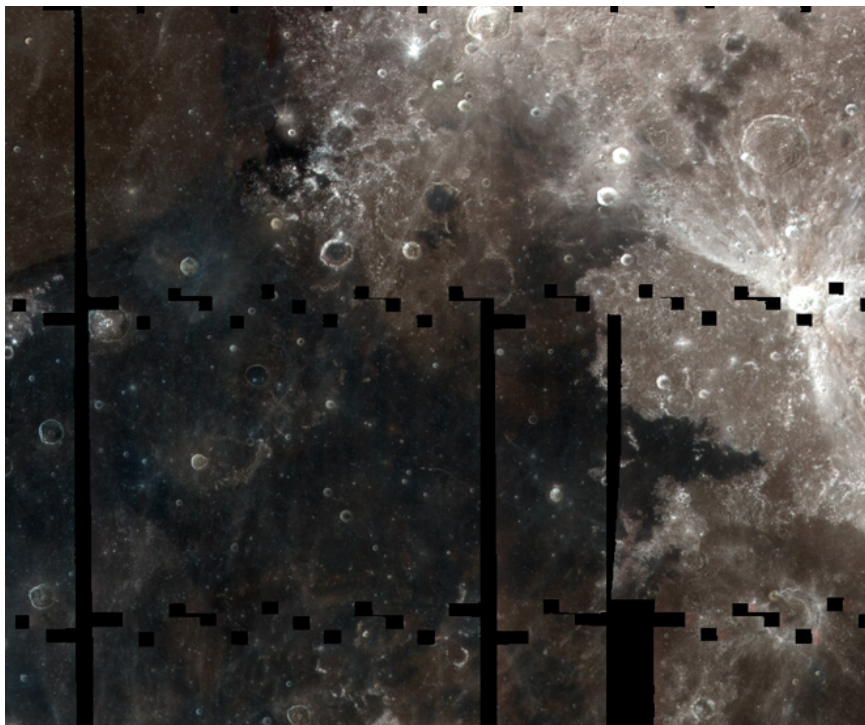
The floor of Tycho crater is covered in many places by a chaotic surface of impact melt forms. Impact melts have extremely complicated thermal histories. When an impacting meteoroid's kinetic energy is large enough, the initial temperature of an impact melt can be much higher than that of normal magma, which is driven by volcanic activity. With blocks, boulders and various impact melt textures, the extremely complicated and chaotic nature of the surface is striking.



New Views of Lunar Pits

Spectacular high Sun view of the Mare Tranquillitatis pit crater revealing boulders on an otherwise smooth floor. When the Sun is well overhead, the floor of the Mare Tranquillitatis pit is illuminated. Scientists estimate the depth to be over 100 meters.

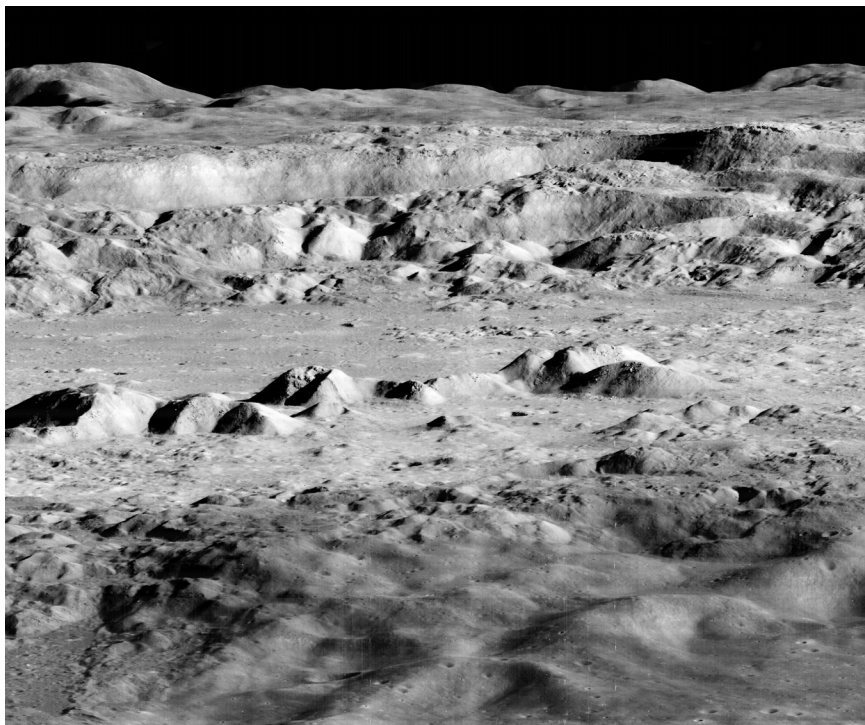
How and when did pit craters form? On the Earth volcanic pit craters are formed as the roof of a lava tube collapses, often while magma is still flowing underground. The resulting opening is often termed a skylight.



Color of the Moon

Color variations on the Moon are subtle; just look at the Moon with your eye. To help distinguish small color variations, the UV and visible spectrum are divided into 7 narrow bands from which scientists can pull out subtle signals related to different minerals.

Colors on the Moon are dominantly controlled by variations in iron and titanium content. The mare regions have low reflectance because they contain relatively high amounts of iron oxide (FeO). Some mare basalts contain unusually high amounts of titanium oxide (TiO_2) in addition to iron oxide, making for even lower reflectance. TiO_2 also shifts the color of the mare from red to blue.



Copernicus Crater

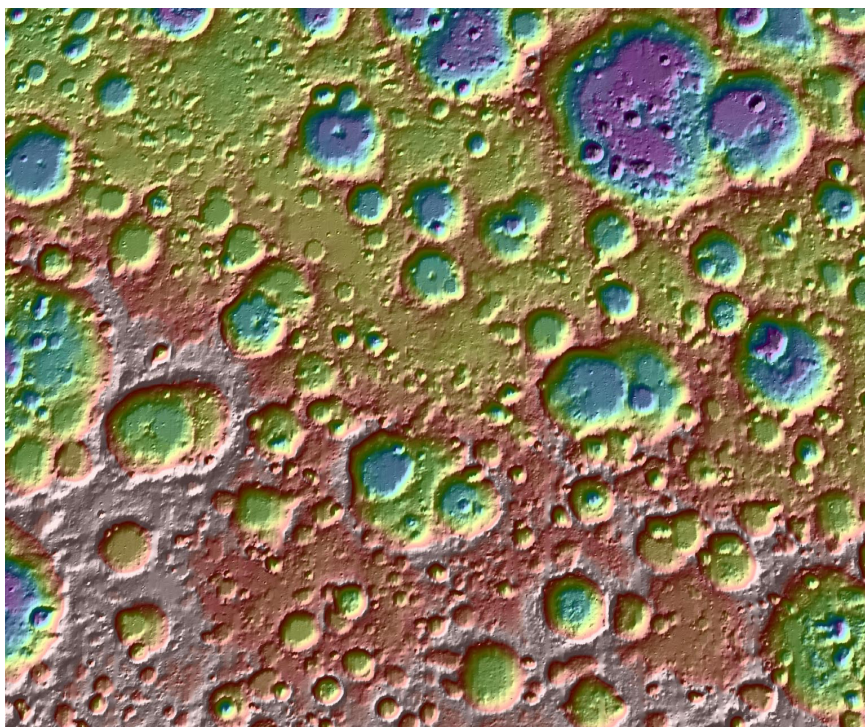
The Lunar Orbiter Image Recovery Project (LOIRP) has released several iconic images taken during the Lunar Orbiter program in the 1960's. Using modern computer technology, LOIRP has been able to produce digital images which greatly exceed the resolution of the original images. The performance of modern hardware and software image processing methods has been significantly enhanced to remove some of the banding artifacts that were derived from imperfections in the spacecraft's original image scanning hardware.

This image, which shows the dramatic landscape within the crater Copernicus, is a re-release of Life Magazine's "Image of the Century" from 1966.



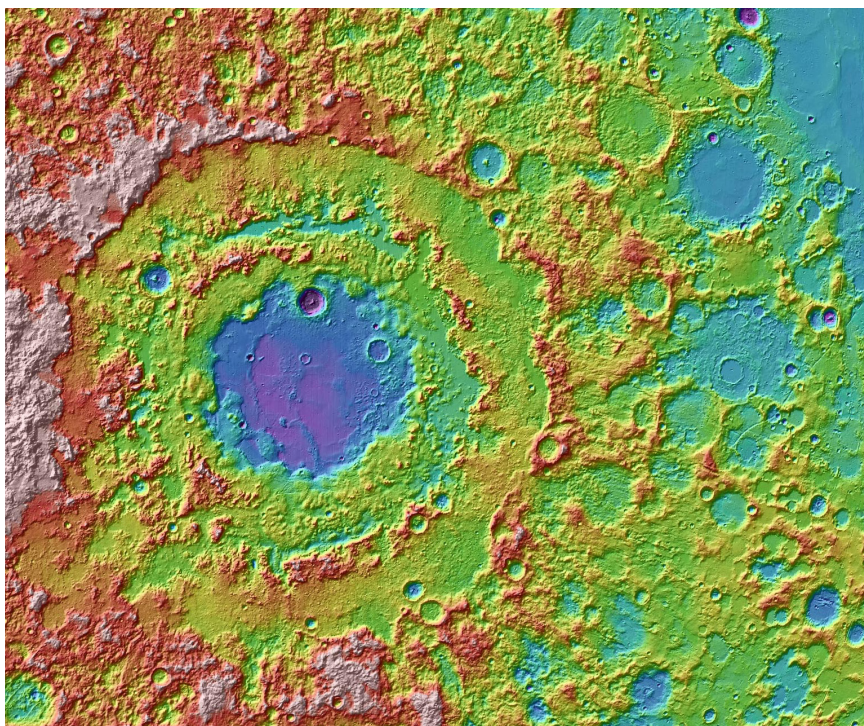
Earthrise

Apollo 8, the first manned mission to the Moon, entered lunar orbit on Christmas Eve, December 24, 1968. That evening, the astronauts--Commander Frank Borman, Command Module Pilot Jim Lovell, and Lunar Module Pilot William Anders--held a live broadcast from lunar orbit, in which they showed pictures of the Earth and Moon as seen from their spacecraft. Said Lovell, "The vast loneliness is awe-inspiring and it makes you realize just what you have back there on Earth."



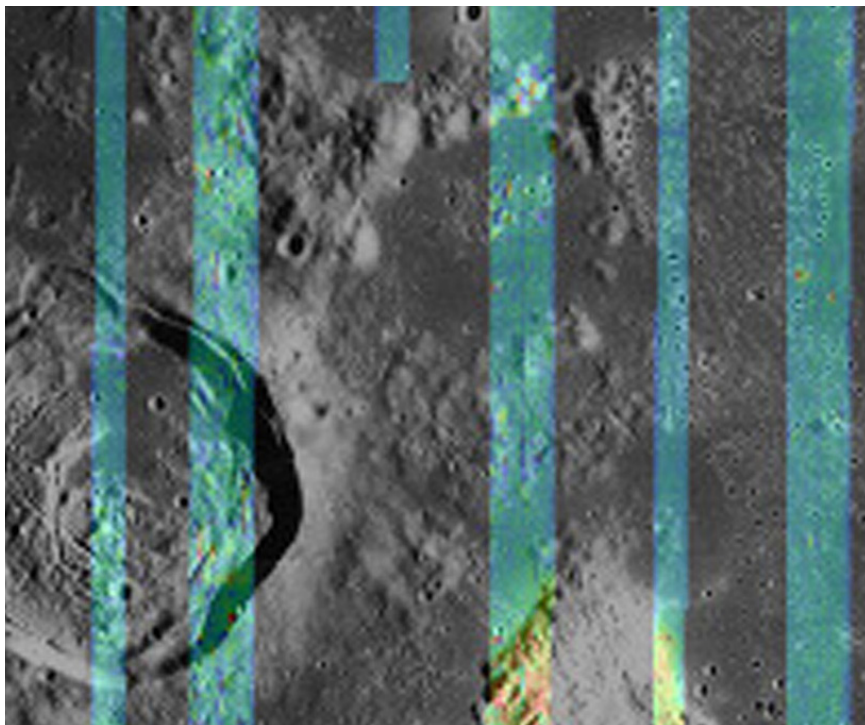
Craters Everywhere

A lunar topographic map showing one of the most densely cratered regions on the Moon. The topography is derived from over 2.4 billion shots made by the Lunar Orbiter Laser Altimeter (LOLA) instrument on board LRO. These most heavily cratered areas are among the best candidates to study and explore to understand the earliest lunar history.



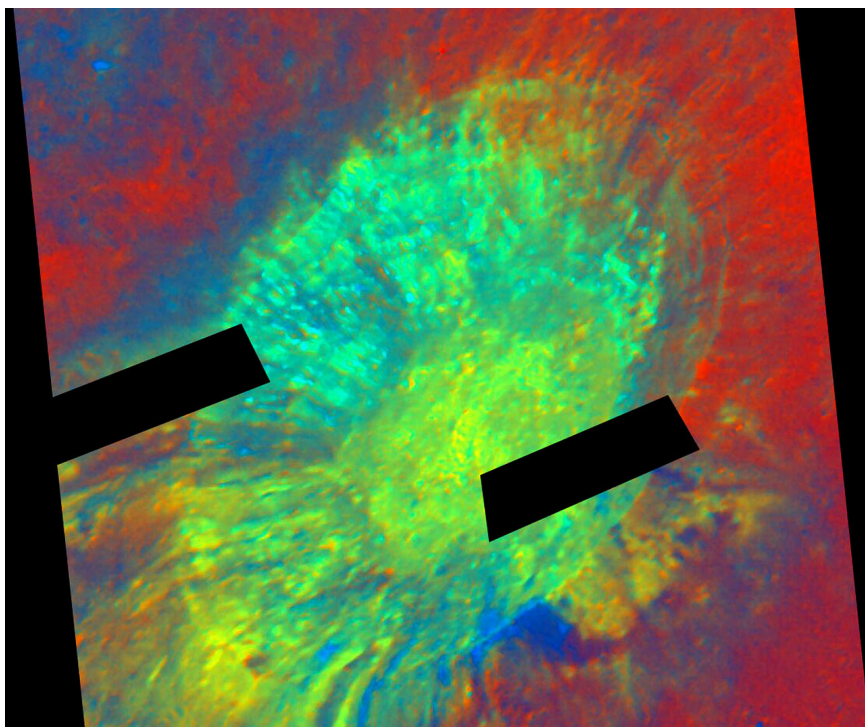
Oriente Basin

A lunar topographic map showing the Orientale basin (930 km diameter), the largest young impact basin on the Moon. This young basin formed from a projectile that impacted the Moon about 3.8 billion years ago, and penetrated deeply into the lunar crust, ejecting millions of cubic kilometers of material into the surrounding areas. These large basins show the effects of such impacts on early planetary crusts in the inner solar system, including the Earth.



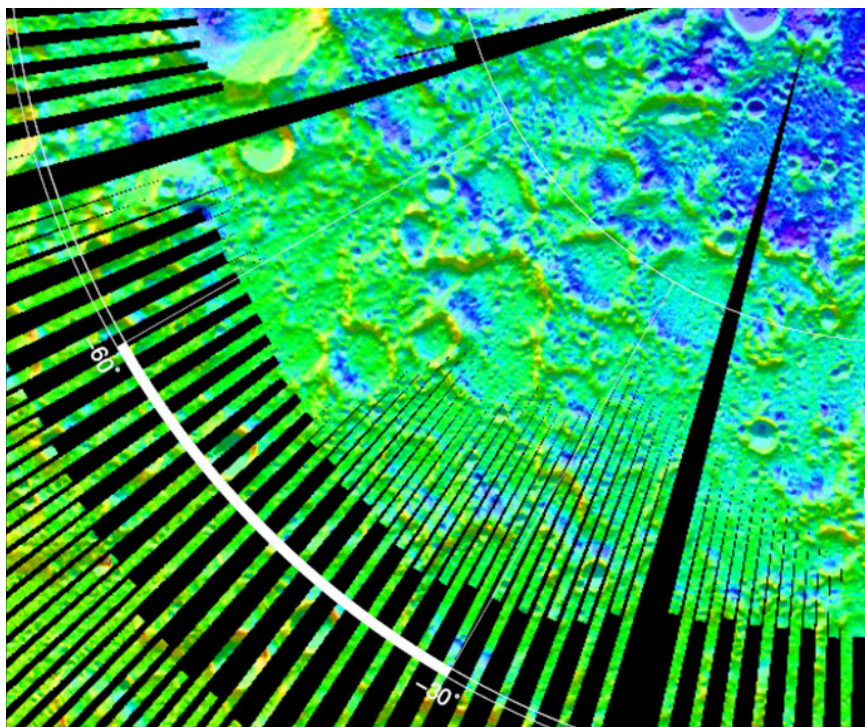
Hansteen Alpha

Diviner data superimposed on a Lunar Orbiter IV mosaic of Hansteen Alpha, which is believed to be a silicic volcano. Red and orange colors indicate highly silicic compositions.



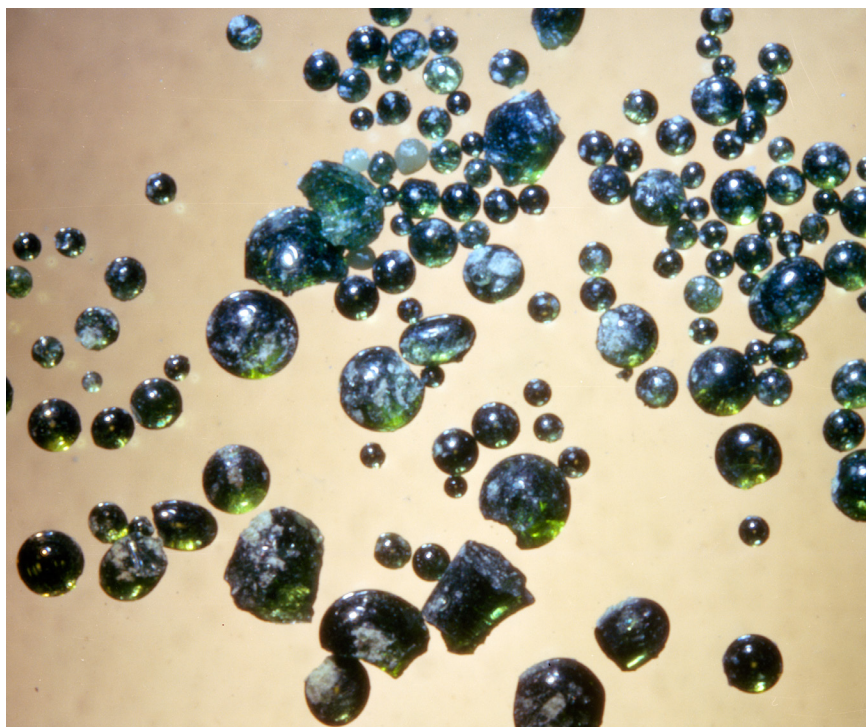
Aristarchus Crater in False Color

This color composite focuses on the 42-kilometer-diameter Aristarchus impact crater, and employs ultraviolet-to visible-color-ratio information to accentuate differences that are potentially diagnostic of ilmenite- (i.e, titanium oxide) bearing materials as well as pyroclastic glasses. The symphony of color within the Aristarchus crater clearly shows a diversity of materials - anorthosite, basalt, and olivine.



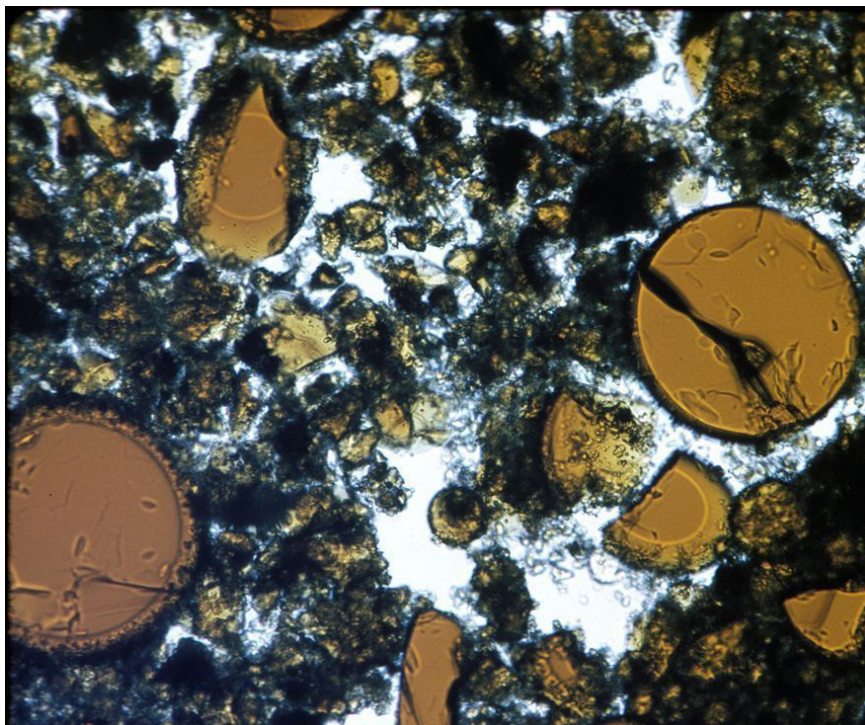
Diviner Observes Extreme Polar Temperatures

This Diviner nighttime brightness temperature map of the Moon's north polar region was acquired close to winter solstice. The Diviner lunar radiometer has been mapping the temperature of the Moon since July, 2009. During this period, Diviner observed the passage of summer solstice in the southern hemisphere and winter solstice in the northern hemisphere. The LRO launch date was chosen so that its orbital plane passed through the noon to midnight plane in October, allowing Diviner to measure the extremes of polar temperatures.



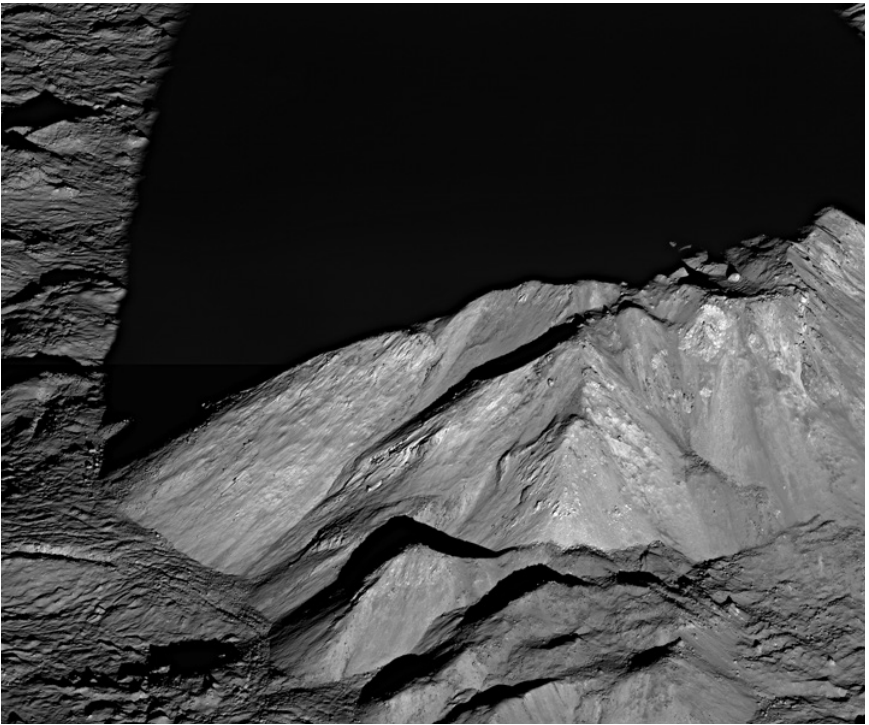
Watery Glasses

Researchers have analyzed lunar volcanic glasses, such as these gathered by the Apollo 15 mission, and used a new analytic technique to detect water. The discovery strongly suggests that water has been a part of the Moon since its early existence – and perhaps since it was first created.



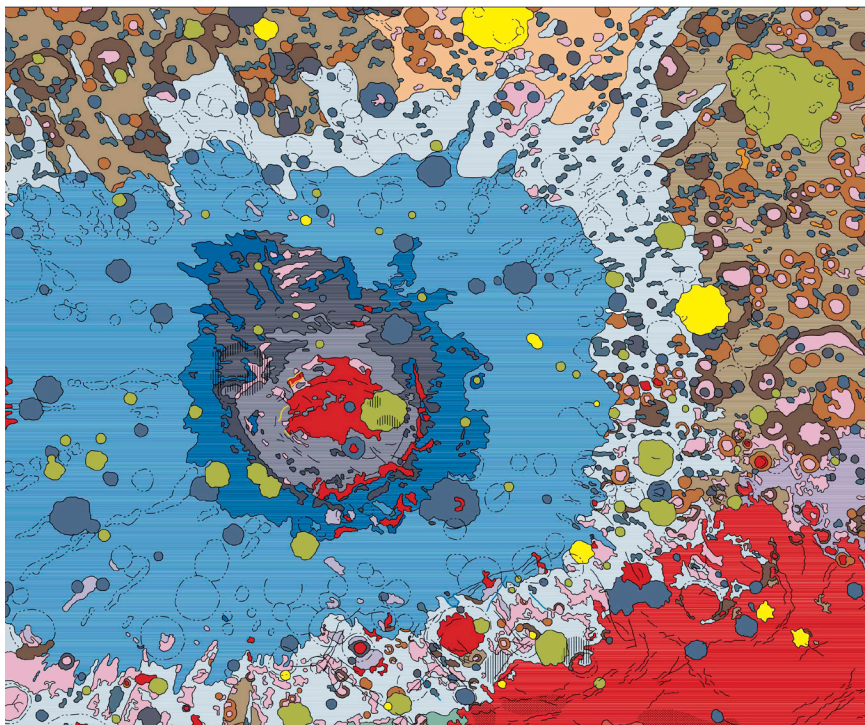
Orange Volcanic Glass

This microscope photo shows whole spheres and partial fragments of orange volcanic glass, of the type recovered from Apollo 17 sample 74220 from which the lunar melt inclusions were recovered. The largest sphere in the center is 0.2 millimeters across.



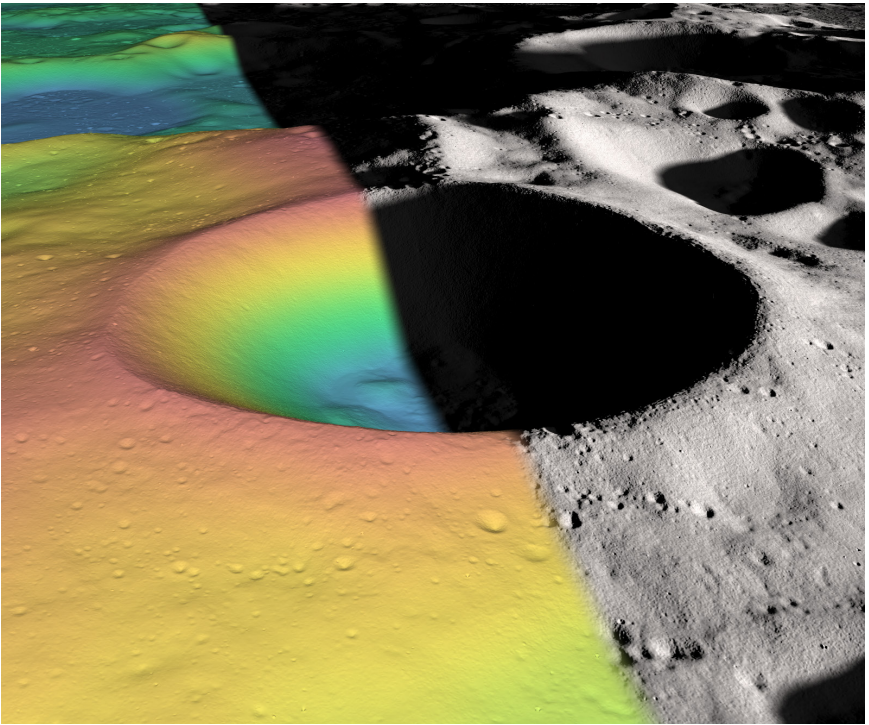
Tycho Central Peak Spectacular!

Oblique view of Tycho crater captured by LRO on June 10th, 2011. The central peak complex in the summit area of this dramatic sunrise view of Tycho crater is about 15 km wide. The summit of the central peak is 2 km (6562 ft) above the crater floor, and the crater floor is about 4700 m (15,420 ft) below the rim. Many “clasts” ranging in size from 10 meters to 100s of meters are exposed in the central peak slopes. Imagine future geologists carefully making their way across these steep slopes, sampling a diversity of rocks brought up from depth.



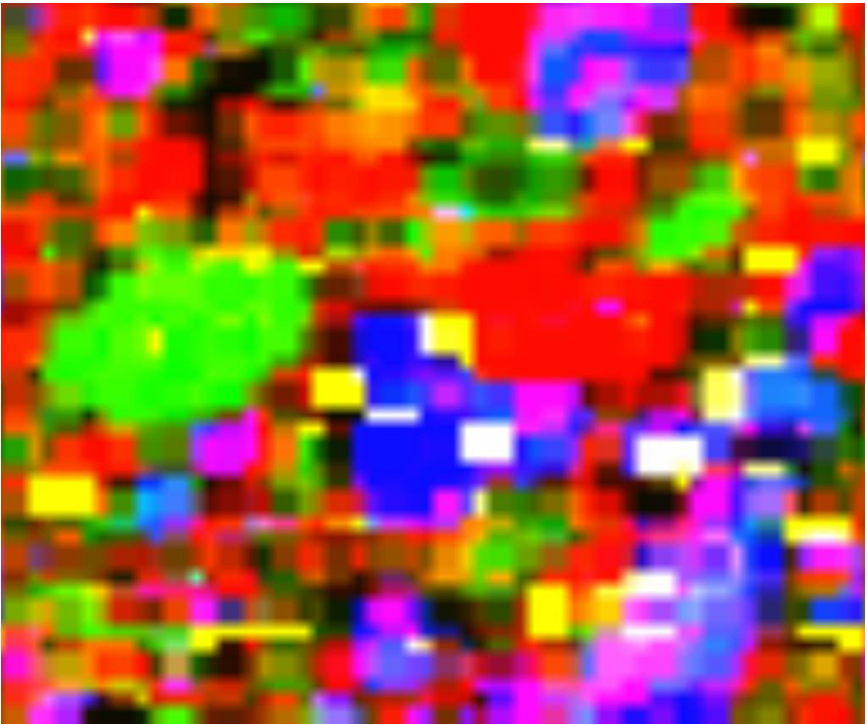
Geologic Map of the Lunar Far Side

This is one of a series of geologic maps prepared by NASA and the U. S. Geological Survey. Each color represents a different type of lunar material. Significant data have been collected from orbit by Apollos 15-17, Zond 6, and Lunar Orbiter 5. Results were obtained from laser altimetry, photogrammetric whole-disk altitude measurements, gamma-ray spectroscopy, subsatellite magnetometry, and gravity calculations based on spacecraft perturbations.



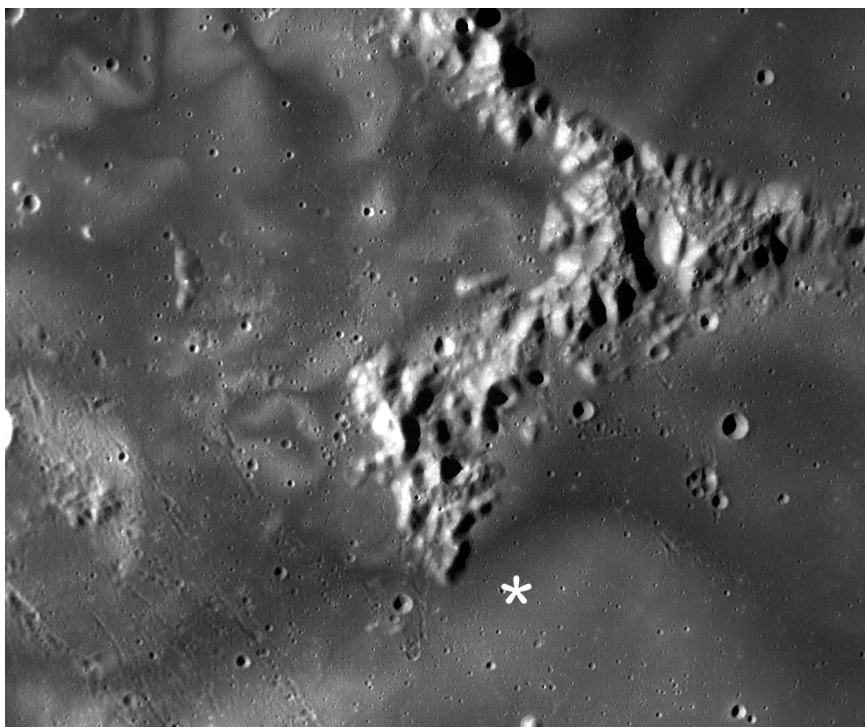
Shackleton Crater Elevation Model

Split image with elevation map (left) and shaded-relief image (right) of Shackleton crater, a 21-km-diameter (12.5-mile-diameter) permanently shadowed crater adjacent to the lunar south pole. The structure of the crater's interior was revealed by a digital elevation model constructed from over 5 million elevation measurements from LRO's LOLA instrument.



Spectroscopy of a Lunar Sample

In a new analysis of a lunar sample collected by Apollo 17, researchers have detected and dated carbon on the Moon in the form of graphite which survived from around 3.8 billion years ago, when the Moon was heavily bombarded by meteorites. Raman spectroscopy of the lunar sample revealed graphite in a rare rolled form known as “graphite whiskers” (shown in yellow), which scientists believe formed in the very high-temperature reactions initiated by a meteorite impact. The discovery also means that the Moon potentially holds a record of the carbon input by meteors into the Earth-Moon system when life was just beginning to emerge on Earth.



Lunar Swirls

Lunar swirls are among the most beautiful and bizarre features on the Moon. Seen as bright, sinuous regions, swirls are associated with weak magnetic anomalies in the Moon's crust. Swirls have no topography associated with them; they are not higher or lower than their surroundings. Instead, it is as if someone has taken a brush and laid down a beautiful swath of bright paint. The star in this image shows the location of a potential future landing site identified by NASA as a region of interest.